



NCERT



CHAPTER WISE TOPIC WISE

LINE BY LINE QUESTIONS

2024



BY
SCHOOL OF
EDUCATORS

TYPES OF BONDS

IONIC/ELECTROVALENT BOND

- Strong electrostatic force of attraction between positive and negative ions.
- Crystalline in nature.
- High M.P. and B.P.
- Soluble in polar solvents. Eg: NaCl, $MgCl_2$ etc.

HYDROGEN BOND

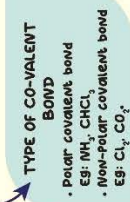
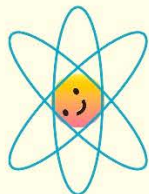
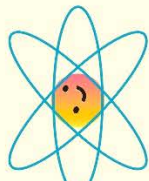
- Bond formed when the -ve end of one molecule attracts the +ve end of other.
- Intermolecular: H-bonding occurs within one single molecule.
- Intramolecular: H-bonding between two different molecules or same or diff. compounds.

CO-VALENT BOND

- Bond formed by mutual sharing of e⁻.
- Low M.P. and B.P.
- Bad conductor of electricity.
- Insoluble in polar solvents but soluble in non-polar solvents. Eg: CH_4 , H_2 , Cl_2 .

IONIC/ELECTROVALENT BOND

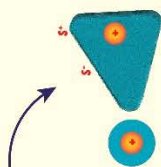
- Strong electrostatic force of attraction between positive and negative ions.
- Crystalline in nature.
- High M.P. and B.P.
- Soluble in polar solvents. Eg: NaCl, $MgCl_2$ etc.



FAJAN'S RULE

- No compounds is 100% ionic or 100% covalent.
- Covalent nature \propto size of anion
- Covalent nature \propto size of cation

Cation polarization of anion by cation



BOND PARAMETERS

FORMAL CHARGE

$$F.C. = V - \frac{L}{2}$$

• Bond length: Equilibrium distance between the nuclei of two bonded atoms

• Bond length $\propto \frac{1}{\text{bond order}}$

BOND ORDER

No. of Bond between the two atoms

BOND ANGLE

Angle between the orbitals containing bonding e⁻ pair around central atom.

BOND ENTHALPY

Amount of energy required to break one mole of bonds.

DIPOLE MOMENT

Product of the magnitude of charge and distance between centres of positive and negative charge.

$$M = \text{charge} \times \text{distance of separation}$$

THEORIES OF CO-VALENT BOND

KOSSEL LEWIS APPROACH

Atoms can combine either by transfer of e⁻ or by sharing of valence e⁻ in order to have an octet in their valence shell.

OCTET RULE

Valence e⁻ are represented by dots around the element.



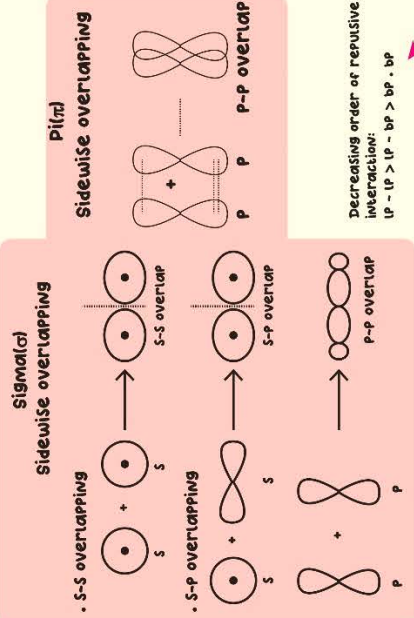
CHEMICAL BONDING AND MOLECULAR STRUCTURE

VALENCE BOND THEORY

VBT

A covalent bond is formed by the overlapping of two half filled atomic orbitals.

TYPE OF OVERLAPPING



HYBRIDISATION

Concept of mixing atomic orbital to form new hybrid

VSEPR THEORY

The shape of a molecule depends upon the numbers of valence shell e⁻ (BP or LP) surrounding in the central atom

MOLECULAR ORBITAL THEORY

- MOT are formed the combine of atomic orbitals.
- No. of molecular orbitals = No. of atomic orbital combined.

MOT

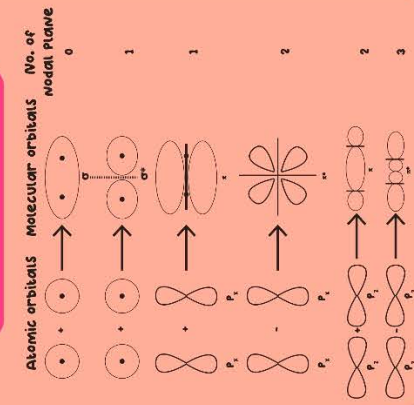
Bonding molecular orbitals

Anti bonding atomic orbitals

ELECTRONIC CONFIGURATION

- $1s < \sigma^{*}1s < \sigma 2s < \sigma^{*}2s < \sigma 2p_z < \pi 2p_x = \pi 2p_y < \sigma^{*}2p_z$ (for O_2, F_2, Ne_2)
- $1s < \sigma^{*}1s < \sigma 2s < \sigma^{*}2s < \pi 2p_x = \pi 2p_y < \sigma 2p_z < \sigma^{*}2p_z$ (for B_2, C_2, N_2)

Formation of Molecular orbitals



Type of Molecule	No. of Bonding pair	No. of Lone pair	Arrangement of e ⁻ pair	Shape	Example
AB_2E	2	1	Trigonal planar	Bent	SO_2, O_3
AB_3E	3	1	Tetrahedral	Trigonal pyramidal	NH_3
AB_4E	2	2	Tetrahedral	Bent	H_2O
AB_5E	4	1	Trigonal bipyramidal	See saw	SF_4
AB_6E	3	2	Trigonal bipyramidal	T-Shape	ClF_3
AB_7E	5	1	Octahedral	Square pyramidal	XeF_5
AB_8E	4	2	Octahedral	Square planar	XeF_4

NCERT LINE BY LINE QUESTIONS

04. CHEMICAL BONDING AND MOLECULAR STRUCTURE

- (1.) Which of the following statements is correct regarding strength of sigma and pi bond
- (a.) Overlapping in sigma bond takes place in small extent. (b.) Overlapping in pi bond takes place in large extent.
- (c.) Overlapping in sigma bond takes place in large extent. (d.) None of these
- (2.) Some statements regarding dipole moment are given below. Identify the correct statements.
- (I) Dipole moment is usually expressed in Debye unit.
 (II) It is a scalar quantity.
 (III) It is the product of the magnitude of the charge and the distance between the centres of positive and negative charge.
- (a.) I and II (b.) II and III
 (c.) I and III (d.) I, II and III
- (3.) If the electronic configuration of an element is $1s^2 2s^2 2p^6 3s^2 3p^6 3d^2 4s^2$, the four electrons involved in chemical bond formation will be
- (a.) $3p^6$ (b.) $3p^6, 4s^2$
 (c.) $3p^6, 3d^2$ (d.) $3d^2, 4s^2$
- (4.) Polarity in a molecule and hence the dipole moment depends primarily on electronegativity of the constituent atoms and shape of a molecule. Which of the following has the highest dipole moment)
- (a.) CO_2 (b.) HI
 (c.) H_2O (d.) SO_2
- (5.) Match the xenon compound in column I with its structure in column II and assign the correct code.
- | Column I | Column II |
|--------------|----------------------------|
| (P) XeF_4 | (i) Pyramidal |
| (Q) XeF_6 | (ii) Square planar |
| (R) $XeOF_4$ | (iii) Distorted octahedral |
| (S) XeO_3 | (iv) Square pyramidal |
- (a.) P-(i), Q-(ii), R-(iii), S-(iv) (b.) P-(ii), Q- (iii), R- (iv), S-(i)
 (c.) P- (ii), O-- (iii), R-(i), S- (iv) (d.) P- (iii), Q- (iv), R-(i), S- (ii)
- (6.) The sum of lone pair of electrons present in the molecule of NH_3 and NF_3 is/are
- (a.) one (b.) two
 (c.) three (d.) zero.

- (7.) What is bond order of He_2 and O_2 respectively.
- (a.) 2 and 0 (b.) 2 and 2
(c.) 1 and 2 (d.) 0 and 2
- (8.) Select the pair of molecules which has tetrahedral molecular geometry.
- (a.) PCl_5 and SF_6 (b.) CH_4 and NH_4^+
(c.) SP_4 and BrF_5 (d.) ClP_3 and H_2O
- (9.) The bond angles of NH_3 , CH_4 and H_2O molecules are
- (a.) 109.5° , 107° and 104.5° respectively. (b.) 107° , 109.5° and 104.5° respectively.
(c.) 104.5° , 107° and 109.5° respectively. (d.) 109.5° , 104.5° and 107° respectively.
- (10.) Some statements regarding formal charge are given below. Identify the correct statement(s).
(I) Formal charges do not indicate real charge separation within the molecule.
(II) Formal charges help in the selection of the lowest energy structure from a number of possible Lewis structures for a given species.
(III) In polyatomic ions, it is feasible to assign a formal charge on each atom.
- (a.) I only (b.) II and III
(c.) I and III (d.) I, II and III
- (11.) What is the factor responsible for the zero overlap?
- (a.) Out of phase due to different orientation direction of approach. (b.) Out of phase due to same orientation direction of approach.
(c.) In phase due to different orientation direction of approach. (d.) In phase due to same orientation direction of approach.
- (12.) Select the pair of molecule which has the same type of hybridisation.
- (a.) BCl_3 and C_2H_6 (b.) C_2H_2 and BeCl_2
(c.) C_2H_4 and CH_4 (d.) NH_3 and C_2H_2
- (13.) Which of the following statements is not correct from the viewpoint of molecular orbital theory.
- (a.) Be_2 is not a stable molecule. (b.) He_2 is not stable but He_2^+ is expected to exist.
(c.) Bond strength of N_2 is maximum among the homonuclear diatomic molecules belonging to the second period. (d.) The order of energies of molecular orbitals in N_2 molecules is $\sigma 2s < \sigma^* 2s < \sigma 2p_z < (\pi 2p_x = \pi 2p_y) < (\pi^* 2p_x = \pi^* 2p_y) < \sigma^* 2p_z$
- (14.) Identify the molecule which has one lone pair of electrons, tetrahedral geometry and trigonal pyramidal shape.
- (a.) SP_4 (b.) BrP_5
(c.) PCl_5 (d.) NH_3

(15.) Select the correct statement.

- (a.) In NF_3 and CO_3^{2-} , nitrogen and fluorine are the central atoms whereas carbon and oxygen occupy the terminal positions. (b.) In NF_3 and CO_3^{2-} , nitrogen and carbon are the central atoms whereas fluorine and oxygen occupy the terminal positions.
- (c.) In NP_3 and CO_3^{2-} , fluorine and oxygen are the central atoms whereas nitrogen and carbon occupy the terminal positions. (d.) In NF_3 and CO_3^{2-} , nitrogen and oxygen are the central atoms whereas fluorine and carbon occupy the terminal positions.

(16.) The direction of the C-H bond cannot be ascertained because

- (a.) the 2s orbital of carbon and the 1s orbital of H are spherically symmetrical and they can overlap in any direction. (b.) the 1s orbital of carbon and the 2s orbital of H are spherically symmetrical and they can overlap in any direction.
- (c.) the 1s orbital of carbon and the 1s orbital of H are spherically symmetrical and they can overlap in any direction. (d.) the 2s orbital of carbon and the 2s orbital of H are spherically symmetrical and they can overlap in any direction.

(17.) Which of the following will be the strongest bond?

- (a.) O-H (b.) N-H
- (c.) O-Cl (d.) F-O

(18.) Some statements regarding octet theory are given below. Identify the correct statement(s).

(I) This theory does not account for the shape of molecules.

(II) It does not explain the relative stability of the molecules.

(III) This theory is totally silent about the energy of a molecule.

- (a.) II only (b.) I and III
- (c.) II and III (d.) I, II and III

(19.) In sp hybridisation

- (a.) 50% s-character and 50% p-character (b.) 25% s-character and 75% p-character
- (c.) 75% s-character and 25% p-character (d.) 40% s-character and 60% p-character

(20.) **Assertion:** O_2 molecule is paramagnetic while H_2 molecule is diamagnetic in nature.

Reason: Bond order of O_2 molecular is two while bond order of H_2 molecule is one.

- (a.) Both A and R are true and R is the correct explanation of A. (b.) Both A and R are true but R is not the correct explanation of A.
- (c.) A is true but R is false. (d.) Both A and R are false.

(21.) Some molecules are given below: $\text{SO}_2, \text{NH}_3, \text{H}_2\text{O}, \text{SP}_4, \text{ClP}_3, \text{BrP}_5, \text{XeF}_4$

How many of them have two lone pair of electrons?

- (a.) Two (b.) Three
- (c.) Four (d.) Five

(22.) As per VSEPR theory, the pairs of electrons tend to occupy such position in space that

- (a.) minimise repulsion and thus maximise distance between them. (b.) maximise repulsion and thus maximise distance between them.

- (c.) minimise repulsion and thus minimise distance between them. (d.) maximise repulsion and thus minimise distance between them.
- (23.) The molecular orbitals are filled in accordance with the
 (a.) aufbau principle. (b.) Pauli's exclusion principle.
 (c.) Hund's rule. (d.) All of these.
- (24.) N_a and N_b denoted for number of electrons present in antibonding and number of electrons present in bonding, then select correct option for stable molecule.
 (a.) $N_b < N_a$ (b.) $N_a = N_b$
 (c.) $N_a < N_b$ (d.) None of these
- (25.) **Assertion:** In NH_3 , N is sp^3 hybridised but bond angle is 107° .
Reason: Shape of NH_3 molecule is trigonal pyramidal.
 (a.) Both A and R are true and R is the correct explanation of A. (b.) Both A and R are true but R is not the correct explanation of A.
 (c.) A is true but R is false. (d.) Both A and R are false.
- (26.) What is the bond angle in the molecule of BeCl_2
 (a.) 60° (b.) 90°
 (c.) 120° (d.) 180°
- (27.) Overlapping of atomic orbitals depends upon
 (a.) the sign (phase) of orbital wave function in space. (b.) direction of orientation of amplitude of orbital wave function in space.
 (c.) both a and b. (d.) none of these.
- (28.) How many lone pairs of electrons are present in SF_4 molecule
 (a.) One (b.) Two
 (c.) Three (d.) Four
- (29.) Which of the following pairs of molecules has expanded octet)
 (a.) $\text{SP}_6, \text{H}_2\text{O}$ (b.) $\text{H}_2\text{SO}_4, \text{LiCl}$
 (c.) PF_5 and SF_6 (d.) CO_2 and PF_5
- (30.) Select the correct order of increasing bond length of $\text{C}=\text{C}$, $\text{C}-\text{C}$, $\text{C}-\text{O}$ and $\text{C}-\text{H}$.
 (a.) $\text{C}-\text{O} < \text{C}-\text{H} < \text{C}-\text{C} < \text{C}=\text{C}$ (b.) $\text{C}-\text{C} < \text{C}=\text{C} < \text{C}-\text{O} < \text{C}-\text{H}$
 (c.) $\text{C}-\text{H} < \text{C}=\text{C}, \text{C}-\text{O} < \text{C}-\text{C}$ (d.) $\text{C}-\text{H} < \text{C}-\text{O} < \text{C}-\text{C} < \text{C}=\text{C}$
- (31.) Net dipole moment (l) of water molecule (H_2O) is 1.85 D. Its values in Cm is equal to
 (a.) $1.35 \times 10^{-30} \text{ Cm}$ (b.) $8.33 \times 10^{-30} \text{ Cm}$
 (c.) $6.17 \times 10^{-30} \text{ Cm}$ (d.) $5.21 \times 10^{-30} \text{ Cm}$

(32.) Which of the following molecules/ions is diamagnetic in nature.

- (a.) O_2^2 (b.) O_2
(c.) O_2 (d.) O_2^+

(33.) Valence bond theory is based on the knowledge of the following:

- (I) Atomic orbitals
(II) Electronic configurations of elements
(III) The overlapping criteria of atomic orbitals
(IV) Principles of variation and superposition

Select the correct option.

- (a.) II and III are correct. (b.) III and IV are correct.
(c.) I and III are correct. (d.) I, II, III and IV are correct.

(34.) Nyholm and Gillespie refined the VSEPR model by explaining that

- (a.) the lone pair electrons in a molecule occupy more space as compared to the bonding pairs of electrons. (b.) the lone pair of electrons in a molecule occupy less space as compared to the bonding pairs of electrons.
(c.) the lone pair and bond pair in a molecule occupy the same space. (d.) None of these.

(35.) Which of the following pairs of species has identical bond order?

- (a.) N_2 and O_2 (b.) P_2 and N_2
(c.) N_2 and HCl (d.) N_2 and CO

(36.) Dipole moment defined as the

- (a.) product of the magnitude of the charge and the distance between the centres of positive and positive charge. (b.) product of the magnitude of the charge and the distance between the centres of negative and negative charge.
(c.) product of the magnitude of the charge and the distance between the centres of positive and negative charge. (d.) product of the magnitude of the resistance and the distance between the neutral nuclei.

(37.) **Assertion:** Dipole moment of NH_3 is greater than that of NP_3 .

Reason: Nitrogen is more electronegative than fluorine.

- (a.) Both A and R are true and R is the correct explanation of A. (b.) Both A and R are true but R is not the correct explanation of A.
(c.) A is true but R is false. (d.) Both A and R are false.

(38.) Some statements regarding bond angle are given below. Identify the correct statement(s).

- (I) Bond angle is the angle between the orbitals containing bonding electron pairs around the central atom in a molecule/complex ion.
(II) Bond angle is expressed in degrees which can be experimentally determined by spectroscopic methods.
(III) Bond angle helps in determining the shape of the molecule/complex ion.
(IV) Bond angle gives some idea regarding the distribution of orbitals around the central atom in a molecule/complex ion.

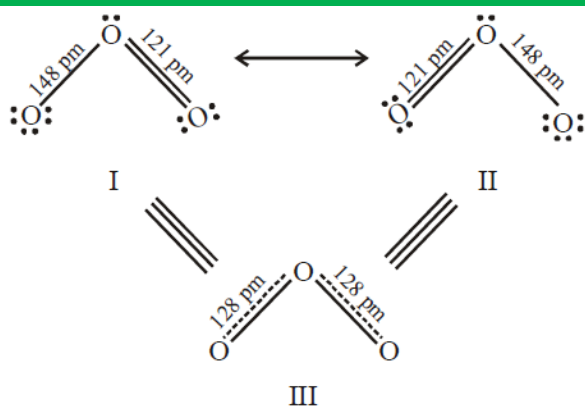
- (a.) III only (b.) I, II and IV
(c.) I, II, III and IV (d.) I and III
- (39.) The types of hybrid orbitals of nitrogen in NO_2^+ , NO_3^- and NH_4^+ respectively are expected to be
- (a.) sp , sp^3 and sp^2 (b.) sp , sp^2 and sp^3
(c.) sp^2 , sp and sp^3 (d.) sp^2 , sp^3 and sp
- (40.) Two statements for polarity of bonds are given below:
(I) The existence of a 100% ionic or covalent bond represents an ideal situation.
(II) In reality no bond or a compound is either completely covalent or ionic.
The given statements I and II are true or false
- (a.) FF (b.) TT
(c.) TF (d.) FT
- (41.) According to VSEPR Theory, the shape of a molecule depends upon the number of valence shell electron pairs
- (a.) bonded electron pair only. (b.) non-bonded electron pair only.
(c.) bonded or non-bonded electron pair. (d.) neither bonded nor non-bonded electron pair.
- (42.) Two statements regarding SP_4 molecule are given below. Identify the correct statements with respect to more stable structure.
(I) If lone pair of electrons present at axial position then molecule is more stable.
(II) If lone pair of electrons present at equatorial position then molecule is less stable.
- (a.) Only I (b.) Only II
(c.) Both I and II (d.) Neither I nor II
- (43.) What is the bond order of H_2 molecule
- (a.) One (b.) Two
(c.) Three (d.) Zero
- (44.) Ionic bonds will be formed more easily
- (a.) between elements with comparatively low ionisation enthalpies and elements with comparatively high negative value of electron gain enthalpy. (b.) between elements with comparatively high ionisation enthalpies and elements with comparatively low negative value of electron gain enthalpy.
(c.) between two elements which consist of low ionisation enthalpy and electron gain enthalpy. (d.) between two elements which consist of high ionisation enthalpy and electron gain enthalpy.
- (45.) **Assertion:** SF_4 molecule has see-saw shape.
Reason: Two lone pair of electrons are present in SF_4 molecules.
- (a.) Both A and R are true and R is the correct explanation of A. (b.) Both A and R are true but R is not the correct explanation of A.

- (c.) A is true but R is false. (d.) Both A and R are false.
- (46.) Which molecule/ion out of the following does not contain unpaired electrons
- (a.) N_2^+ (b.) O_2
(c.) O_2^{2-} (d.) B_2
- (47.) What is the hybridisation of a molecule which has square planar shape
- (a.) dsp^2 (b.) sp^3d
(c.) sp^3d^2 (d.) sp^3
- (48.) The dipole moment of HF may be represented as:
- $\begin{array}{c} \text{+} \quad \text{+} \\ \text{H} \text{---} \text{F} \text{---} \end{array}$
- This arrow symbolises the direction of the shift of
- (a.) proton density in the molecule. (b.) electron density in the molecule.
(c.) neutron density in the molecule. (d.) proton and neutron densities in the molecule.
- (49.) Some conditions for the combination of atomic orbitals are given below:
(I) The combining atomic orbitals must have the same or nearly the same energy.
(II) The combining atomic orbitals must have the same symmetry about the molecular axis.
(III) The combining atomic orbitals must overlap to the maximum extent.
Select the correct statement(s).
- (a.) Only I (b.) Only III
(c.) I and III (d.) I, II and III
- (50.) Bond length is defined as the equilibrium distance between the nuclei of two bonded atoms in a molecule and it is measured by
- (a.) spectroscopic technique. (b.) X-ray diffraction technique.
(c.) electron-diffraction technique. (d.) all of these.

TOPIC WISE PRACTICE QUESTIONS

TOPIC 1: Electrovalent, Covalent and Coordinate Bonding

1. Which of the following combination will form an electrovalent bond ?
1) P and Cl 2) NH_3 and BF_3 3) H and Ca 4) H and S
2. Which has a giant covalent structure?
1) PbO_2 2) SiO_2 3) NaCl 4) $AlCl_3$
3. Which one of the following contains a co-ordinate covalent bond ?
1) H_2O 2) HCl 3) $BaCl_2$ 4) $N_2H_5^+$
4. The number of dative bonds in sulphuric acid molecule is
1) 0 2) 1 3) 2 4) 4
5. Which of the following statements is not true about covalent compounds?
1) They may exhibit space isomerism 2) They have low melting and boiling points

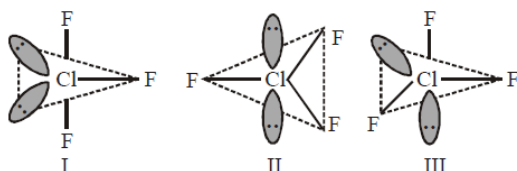


- 1) I and III only 2) II and III only 3) I and II only 4) All
25. Which of the following salt shows maximum covalent character?
 1) AlCl_3 2) MgCl_2 3) CsCl 4) LaCl_3
26. Pauling's electronegativity values for elements are useful in predicting :
 1) polarity of bonds in molecules 2) ionic and covalent nature of bonds
 3) coordination number 4) both 1) and 2)
27. The molecule which has zero dipole moment is
 1) CH_3Cl 2) NF_3 3) BF_3 4) ClO_2
28. Which bond angle q would result in the maximum dipole moment for the triatomic molecule YXY
 1) $q = 90^\circ$ 2) $q = 120^\circ$ 3) $q = 150^\circ$ 4) $q = 180^\circ$
29. Polarizability of halide ions increases in the order
 1) F^- , I^- , Br^- , Cl^- 2) Cl^- , Br^- , I^- , F^- 3) I^- , Br^- , Cl^- , F^- 4) F^- , Cl^- , Br^- , I^-
30. If one assumes linear structure instead of bent structure for water, then which one of the following properties cannot be explained?
 1) The formation of intermolecular hydrogen bond in water.
 2) The high boiling point of water.
 3) Solubility of polar compounds in water.
 4) Ability of water to form coordinate covalent bond.

TOPIC 3: VSEPR Theory, VBT Theory and Hybridization

31. The angle between the overlapping of one s -orbital and one p -orbital is
 1) 180° 2) 120° 3) $109^\circ 28'$ 4) $120^\circ 60'$
32. Equilateral shape has
 1) sp hybridisation 2) sp^2 hybridisation 3) sp^3 hybridisation 4) None of these
33. Which one of the following has the shortest carbon-carbon bond length ?
 1) Benzene 2) Ethene 3) Ethyne 4) Ethane
34. Which of the following is the correct increasing order of lone pair of electrons on the central atom?
 1) $\text{IF}_7 < \text{IF}_5 < \text{ClF}_3 < \text{XeF}_2$ 2) $\text{IF}_7 < \text{XeF}_2 < \text{ClF}_3 < \text{IF}_5$
 3) $\text{IF}_7 < \text{ClF}_3 < \text{XeF}_2 < \text{IF}_5$ 4) $\text{IF}_7 < \text{XeF}_2 < \text{IF}_5 < \text{ClF}_3$
35. In which one of the following molecules the central atom is said to adopt sp^2 hybridization?
 1) BeF_2 2) BF_3 3) C_2H_2 4) NH_3
36. Which of the following two are isostructural?
 1) NH_3 , BF_3 2) PCl_5 , ICl_5 3) XeF_2 , IF_2^- 4) CO_3^{2-} , SO_3^{2-}
37. The decreasing values of bond angles from NH_3 (106°) to SbH_3 (101°) down group-15 of the periodic table is due to
 1) decreasing bp - bp repulsion 2) decreasing electronegativity
 3) increasing bp - bp repulsion 4) increasing lp - bp repulsion
38. The shape of ClO_3^- ion according to Valence Shell Electron Pair Repulsion (VSEPR) theory will be
 1) planar triangular 2) pyramidal 3) tetrahedral 4) square planar
39. Which of the following molecules has trigonal planar geometry?
 1) BF_3 2) NH_3 3) PCl_3 4) IF_3

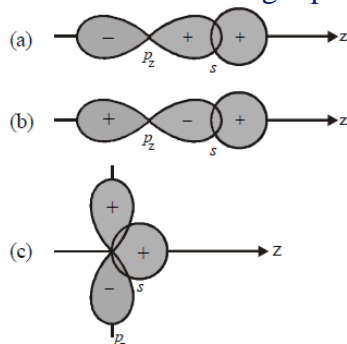
40. Linear combination of two hybridized orbitals belonging to two atoms and each having one electron leads to a
 1) sigma bond 2) double bond 3) co-ordinate covalent bond 4) pi bond.
41. Which of the following statements is not correct for sigma and pi-bonds formed between two carbon atoms?
 1) Sigma-bond determines the direction between carbon atoms but a pi-bond has no primary effect in this regard
 2) Sigma-bond is stronger than a pi-bond
 3) Bond energies of sigma- and pi-bonds are of the order of 264 kJ/mol and 347 kJ/mol, respectively
 4) Free rotation of atoms about a sigma-bond is allowed but not in case of a pi-bond
42. How many s and p bonds are present in toluene?
 1) $3\pi + 8\sigma$ 2) $3\pi + 10\sigma$ 3) $3\pi + 15\sigma$ 4) $6\pi + 3\sigma$
43. The number of lone pair and bond pair of electrons on the sulphur atom in sulphur dioxide molecule are respectively
 1) 1 and 3 2) 4 and 1 3) 3 and 1 4) 1 and 2
44. How many sigma bonds are in a molecule of diethyl ether, $C_2H_5OC_2H_5$
 1) 14 2) 12 3) 8 4) 16
45. Which of the following statements is not correct?
 1) Hybridisation is the mixing of atomic orbitals prior to their combining into molecular orbitals
 2) sp^2 hybrid orbitals are formed from two p -atomic orbitals and one s -orbital
 3) d^2sp^3 hybrid orbitals are directed towards the corners of a regular octahedron
 4) dsp^3 hybrid orbitals are all at 90° to one another
46. Which of the following species has a linear shape ?
 1) SO_2 2) NO_2^+ 3) CH_4 4) NO_2^-
47. Using VSEPR theory, predict the species which has square pyramidal shape
 1) $SnCl_2$ 2) CCl_4 3) SO_3 4) BrF_5
48. Amongst the following, the molecule/ion that is linear is :
 1) SO_2 2) CO_2 3) ClO_2^- 4) NO_2^-
49. Which of the following structure is most stable ?



Choose the correct option.

- 1) Only I 2) Only II 3) Only III 4) All three have same stability
50. The true statements from the following are
 1. PH_5 and $BiCl_5$ do not exist 2. $p\pi - d\pi$ bond is present in SO_2
 3. Electrons travel with the speed of light 4. SeF_4 and CH_4 have same shape
 5. I_3^+ has bent geometry
 1) 1, 3 2) 1, 2, 5 3) 1, 3, 5 4) 1, 2, 4
51. The hybrid state of S in SO_3 is similar to that of
 1) C in C_2H_2 2) C in C_2H_4 3) C in CH_4 4) C in CO_2
52. Allyl cyanide molecule contains
 1) 9 sigma bonds, 4 pi bonds and no lone pair 2) 9 sigma bonds, 3 pi bonds and one lone pair
 3) 8 sigma bonds, 5 pi bonds and one lone pair 4) 8 sigma bonds, 3 pi bonds and two lone pairs
53. All bond angles are exactly equal to $109^\circ 28'$ in :
 1) methyl chloride 2) iodoform 3) chloroform 4) carbon tetrachloride
54. Which has the least bond angle
 1) NH_3 2) BeF_2 3) H_2O 4) CH_4
55. The shape of IF_6^- is :

- 1) Trigonally distorted octahedron 2) Pyramidal
3) Octahedral 4) Square antiprism
56. Which of the following statements is not correct?
1) Double bond is shorter than a single bond 2) Sigma bond is weaker than a p (pi) bond
3) Double bond is stronger than a single bond 4) Covalent bond is stronger than hydrogen bond
57. In which of the following pair both the species have sp^3 hybridization?
1) H_2S , BF_3 2) SiF_4 , BeH_2 3) NF_3 , H_2O 4) NF_3 , BF_3
58. Which of the following represents zero overlap of atomic orbitals.



(d) All of these

59. The structure of the noble gas compound XeF_4 is :
1) square planar 2) distorted tetrahedral 3) tetrahedral 4) octahedral
60. Which of the following pairs of species have identical shapes?
1) NO_2^+ and NO_2^- 2) PCl_5 and BrF_5 3) XeF_4 and ICl_4^- 4) $TeCl_4$ and XeO_4
61. Amongst NO_3^- , AsO_3^{3-} , CO_3^{2-} , ClO_3^- , SO_3^{2-} and BO_3^{3-} , the non-planar species are
1) CO_3^{2-} , SO_3^{2-} , BO_3^{3-} 2) AsO_3^{3-} , ClO_3^- , SO_3^{2-} 3) NO_3^- , CO_3^{2-} , BO_3^{3-} 4) SO_3^{2-} , NO_3^- , BO_3^{3-}
62. What is the shape of the IBr_2^- ion?
1) Linear 2) Bent shape with bond angle of about 90°
3) Bent shape with bond angle of about 109° 4) Bent shape with bond angle of about 120°
63. According to VSEPR theory, in which species do all the atoms lie in the same plane?
1. CH_3^+ 2. CH_3^-
1) 1 only 2) 2 only 3) both 1 and 2 4) neither 1 nor 2
64. Which bonds are formed by a carbon atom with sp^2 -hybridisation?
1) 4 π -bonds 2) 2 π -bonds and 2 σ -bonds 3) 1 π -bonds and 3 σ -bonds 4) 4 σ -bonds
65. SF_2 , SF_4 and SF_6 have the hybridisation at sulphur atom respectively as :
1) sp^2 , sp^3 , sp^2d^2 2) sp^3 , sp^3 , sp^3d^2 3) sp^3 , sp^3d , sp^3d^2 4) sp^3 , spd^2 , d^2sp^3
66. The strength of bonds formed by $s-s$, $p-p$ and $s-p$ overlap is in the order of
1) $s-p > s-s > p-p$ 2) $p-p > s-s > s-p$ 3) $s-s > p-p > s-p$ 4) $s-s > s-p > p-p$

TOPIC 4: MOT and Hydrogen Bonding

67. The bond order in N_2^+ is
1) 1.5 2) 3.0 3) 2.5 4) 2.0
68. The molecular electronic configuration of H_2^+ ion is?
1) $(\sigma 1s)^2$ 2) $(\sigma 1s)^2 (\sigma^* 1s)^2$ 3) $(\sigma 1s)^2 (\sigma^* 1s)^1$ 4) $(\sigma 1s)^3$
69. In the change of NO^+ to NO , the electron is added to
1) σ - orbital 2) π - orbital 3) σ^* - orbital 4) π^* - orbital
70. The correct statement with regard to H_2^+ and H_2^- is
1) Both H_2^+ and H_2^- do not exist 2) H_2^- is more stable than H_2^+
3) H_2^+ is more stable than H_2^- 4) Both H_2^+ and H_2^- are equally stable
71. If N_x is the number of bonding orbitals of an atom and N_y is the number of antibonding orbitals, then the molecule/atom will be stable if
1) $N_x > N_y$ 2) $N_x = N_y$ 3) $N_x < N_y$ 4) $N_x \leq N_y$

72. In an anti-bonding molecular orbital, electron density is minimum
 - 1) around one atom of the molecule
 - 2) between the two nuclei of the molecule
 - 3) at the region away from the nuclei of the molecule
 - 4) at no place
73. When two atomic orbitals combine, they form
 - 1) one molecular orbital
 - 2) two molecular orbital
 - 3) three molecular orbital
 - 4) four molecular orbital
74. Of the following hydrides which one has the lowest boiling point?
 - 1) AsH_3
 - 2) SbH_3
 - 3) PH_3
 - 4) NH_3
75. Which one of the following is the correct order of interactions?
 - 1) covalent < hydrogen bonding < van der Waals < dipole-dipole
 - 2) van der Waals < hydrogen bonding < dipole-dipole < covalent
 - 3) van der Waals < dipole-dipole < hydrogen bonding < covalent
 - 4) dipole-dipole < van der Waals < hydrogen bonding < covalent
76. An ether is more volatile than an alcohol having the same molecular formula. This is due to
 - 1) alcohols having resonance structures
 - 2) intermolecular hydrogen bonding in ethers
 - 3) intermolecular hydrogen bonding in alcohols
 - 4) dipolar character of ethers
77. Paramagnetism is exhibited by molecules
 - 1) not attracted into a magnetic field
 - 2) containing only paired electrons
 - 3) carrying a positive charge
 - 4) containing unpaired electrons
78. Hydrogen bonding is maximum in :
 - 1) $\text{C}_2\text{H}_5\text{OH}$
 - 2) CH_3OCH_3
 - 3) $(\text{CH}_3)_2\text{C}=\text{O}$
 - 4) CH_3CHO
79. What is the dominant intermolecular force or bond that must be overcome in converting liquid CH_3OH to a gas?
 - 1) Dipole-dipole interaction
 - 2) Covalent bonds
 - 3) London dispersion force
 - 4) Hydrogen bonding
80. In O_2^- , O_2 and O_2^{+} molecular species, the total number of antibonding electrons respectively are
 - 1) 7, 6, 8
 - 2) 1, 0, 2
 - 3) 6, 6, 6
 - 4) 8, 6, 8

NCERT LINE BY LINE QUESTIONS – ANSWERS

(1.)	c	(2.)	c	(3.)	d	(4.)	c	(5.)	b
(6.)	b	(7.)	d	(8.)	b	(9.)	b	(10.)	d
(11.)	a	(12.)	b	(13.)	d	(14.)	d	(15.)	b
(16.)	a	(17.)	a	(18.)	d	(19.)	a	(20.)	b
(21.)	b	(22.)	a	(23.)	d	(24.)	c	(25.)	b
(26.)	d	(27.)	c	(28.)	a	(29.)	c	(30.)	c
(31.)	c	(32.)	a	(33.)	d	(34.)	a	(35.)	d
(36.)	c	(37.)	c	(38.)	c	(39.)	b	(40.)	b
(41.)	c	(42.)	d	(43.)	a	(44.)	a	(45.)	c
(46.)	c	(47.)	a	(48.)	b	(49.)	d	(50.)	d

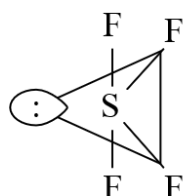
TOPIC WISE PRACTICE QUESTIONS – ANSWERS

1) 3	2) 3	3) 4	4) 3	5) 3	6) 1	7) 1	8) 2	9) 4	10) 2
11) 2	12) 4	13) 4	14) 1	15) 2	16) 1	17) 2	18) 1	19) 4	20) 2
21) 2	22) 3	23) 2	24) 3	25) 1	26) 4	27) 3	28) 1	29) 4	30) 3
31) 1	32) 2	33) 3	34) 1	35) 2	36) 3	37) 1	38) 2	39) 1	40) 1
41) 3	42) 3	43) 4	44) 1	45) 4	46) 2	47) 4	48) 2	49) 1	50) 2
51) 2	52) 2	53) 4	54) 3	55) 1	56) 2	57) 3	58) 3	59) 1	60) 3
61) 2	62) 1	63) 1	64) 3	65) 3	66) 4	67) 3	68) 3	69) 4	70) 3

NCERT LINE BY LINE QUESTIONS – SOLUTIONS

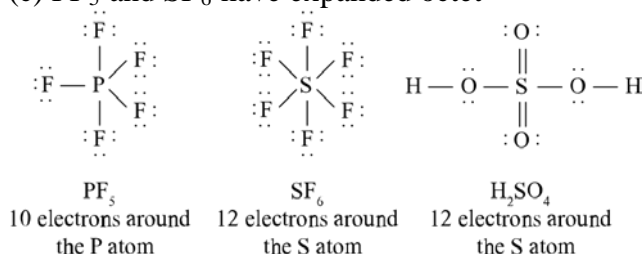
- (1.) (c) Basically the strength of a bond depends upon the extent of overlapping. In case of sigma bond, the overlapping of orbitals takes place to a larger extent. Hence, it is stronger as compared to the pi bond where the extent of overlapping occurs to a smaller extent.
- (2.) (c) Dipole moment is a vector quantity and by convention it is depicted by the small arrow with tail on the negative centre and head pointing towards the positive centre.
- (3.) (d) Electrons from outermost shells ns and $(n-1)d$ take part in bond formation for transition elements.
Assertion-Reason Type Questions
- (4.) (c) H_2O has highest dipole moment.
- (5.) (b) $XeP_4 - sp^3d^2 - l.p. = 2$, square planar
 $XeF_6 - sp^3d^3 - l.p. = 1$, distorted octahedral
 $XeOF_4 - sp^3d^2 - l.p. = 1$, square pyramidal
 $XeO_3 - sp^3 - l.p. = 1$, pyramidal
- (6.) (b) Both the molecules, NH_3 and NF_3 , have pyramidal shape with a lone pair of electrons. Therefore, the sum of lone pair of electrons present in the molecule of NH_3 and NF_3 is two.
- (7.) (d) Electronic configuration of $He_2 : (\sigma 1s)^2 (\sigma^* 1s)^2$
 Bond order of He_2 is $\frac{1}{2}(2 - 2) = 0$
 While bond order of O_2 is two.
- (8.) (b) CH_4 and NH_4^+ both have tetrahedral molecular geometry.
- (9.) (b) The bond angles of NH_3 , CH_4 and H_2O molecules are 107° , 109.5° and 104.5° respectively.
- (10.) (d) All the given statements regarding formal charge are correct.
- (11.) (a) Zero overlap due to the out of phase for different orientation direction of approach.
- (12.) (b) Molecule C_2H_2 and $BeCl_2$ both have sp hybridisation.
- (13.) (d) The correct order of energies of molecular orbitals in N_2 molecule is
 $\sigma 2s < \sigma^* 2s < (\pi 2p_x = \pi 2p_y) < \sigma 2p_z < (\pi^* 2p_x = \pi^* 2p_y) < \sigma^* 2p_z$
- (14.) (d) Ammonia (NH_3) has one lone pair of electrons, tetrahedral molecular geometry and trigonal pyramidal shape.
- (15.) (b) In general, the least electronegative atom occupies the central position in the molecule/ion. For example, in the NF_3 and CO_3^{2-} , nitrogen and carbon are the central atoms whereas fluorine and oxygen occupy the terminal positions.
- (16.) (a) The direction of the C - H bond cannot be ascertained because the $2s$ orbital of carbon and the $1s$ orbital of H are spherically symmetrical and they can overlap in any direction.
- (17.) (a) O-H will be the strongest bond.
- (18.) (d) All the given statements regarding octet theory are correct.
- (19.) (a) In sp hybridisation, 50 % s -character and 50 % p -character.
- (20.) (b) Both assertion and reason are true statements.
- (21.) (b) Among the given molecules, H_2O , ClP_3 , and XeF_4 have two lone pair of electrons. SO_2 , NH_3 , SF_4 and BrF_5 have one lone pair of electron.
- (22.) (a) As per postulates of VSEPR theory, the pairs of electrons tend to occupy such positions in space that minimise repulsion and thus maximise distance between them.

- (23.) (d) The molecular orbitals like atomic orbitals are filled in accordance with the aufbau principle obeying the Pauli's exclusion principle and the Hund's rule.
- (24.) (c) A positive bond order, *i.e.* $N_b > N_a$, means a stable molecule while a negative, *i.e.* $N_b < N_a$, or zero (*i.e.*, $N_b = N_a$) bond order means an unstable molecule.
- (25.) (b) Both assertion and reason are true statement.
- (26.) (d) BeCl_2 has sp -hybridisation, the two sp -hybrid orbitals are oriented in opposite direction forming an angle of 180° .
- (27.) (c) Overlapping of atomic orbitals depends upon the sign (phase) and direction of orientation of amplitude of orbital wave function in space.
- (28.) (a) One lone pair of electron is present in SF_4 molecule.



SF_4 molecule

- (29.) (c) PF_5 and SF_6 have expanded octet



- (30.) (c) Correct order of increasing bond length is
 $\text{C}-\text{H} < \text{C}=\text{C} < \text{C}-\text{O} < \text{C}-\text{C}$.
- (31.) (c) Given, net dipole moment, $\mu = 1.85\text{D}$
 Net dipole moment, $\mu = 1.85 \times 3.33564 \times 10^{-30} \text{Cm} = 6.17 \times 10^{-30} \text{Cm}$.
- (32.) (a) O_2^{2-} ion, all the electrons are present in pair form, therefore they are diamagnetic in nature.
- (33.) (d) A discussion of the valence bond theory is based on the knowledge of atomic orbitals, electronic configurations of elements, the overlap criteria of atomic orbitals, the hybridisation of atomic orbitals and the principles of variation and superposition.
- (34.) (a) Nyholm and Gillespie refined the VSEPR model by explaining that the lone pairs are localised on the central atom, each bonded pair is shared between two atoms. As a result, the lone pair electrons in a molecule occupy more space as compared to the bonding pairs of electrons.
- (35.) (d) Isoelectronic molecules and ions have identical bond orders, for example, F_2 and O_2^{2-} have bond order 1. N_2 , CO and NO^+ have bond order 3.
- (36.) (c) As a result of polarisation, the molecule possesses the dipole moment which can be defined as the product of the magnitude of the charge and the distance between the centres of positive and negative charge. It is usually designated by a Greek letter μ . Mathematically, it is expressed as follows:
 Dipole moment (μ) = Charge (Q) \times Distance of separation (r).
- (37.) (c) Fluorine is more electronegative than nitrogen.
- (38.) (c) All the given statements regarding bond angle of molecule/complexion are correct.
- (39.) (b) NO_2^+ : sp hybridisation
 NO_3^- : sp^2 hybridisation
 NH_4^+ : sp^3 hybridisation

- (40.) (b) Both the given statements regarding polarity of bonds are true.
- (41.) (c) The shape of a molecule depends upon the number of valence shell electron pairs (bonded or non-bonded) around the central atom.
- (42.) (d) In SF_4 molecule, if lone pair of electrons is present at axial position then molecule is less stable and if lone pair of electrons is present at equatorial position then molecule is more stable.
- (43.) (a) Electronic Configuration of $\text{H}_2 : (\sigma 1s)^2$
 The bond order of H_2 molecule can be calculated as

$$\text{Bond order} = \frac{N_b - N_a}{2} = \frac{2 - 0}{2} = 1$$
- (44.) (a) Ionic bonds will be formed more easily between elements with comparatively low ionisation enthalpies and elements with comparatively high negative value of electron gain enthalpy.
- (45.) (c) One lone pair of electron is present in SF_4 molecule.
- (46.) (c) Among the given molecules/ions O_2^2 does not contain unpaired electrons.
- (47.) (a) The hybridisation of a molecule which has square planar shape is dsp^2 .
- (48.) (b) $\text{H} - \ddot{\text{F}}:$ This arrow symbolises the direction of the shift of electron density in the molecule.
- (49.) (d) All the given conditions are correct for the combination of atomic orbitals.
- (50.) (d) Bond lengths are measured by spectroscopic, X-ray diffraction and electron-diffraction techniques.

TOPIC WISE PRACTICE QUESTIONS – SOLUTIONS

1. (3) Higher the difference in electronegativity between the two atoms, more will be electrovalent character of the bond. Among given choices, calcium and hydrogen have maximum difference in their electronegativities.
2. 3)
3. 4)

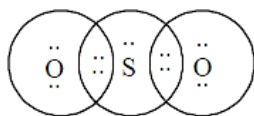
$\begin{array}{c} \text{H} - \text{O} \\ | \\ \text{H} \end{array}$
(a)

$\text{H} - \text{Cl}$
(b)

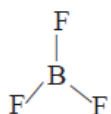
$\text{Cl} - \text{Ba} - \text{Cl}$
(c)

$\begin{array}{c} \text{H}_2\ddot{\text{N}} - \text{NH}_2 \\ \downarrow \\ \text{H}^+ \end{array}$
(d)
4. 3)
5. 3)
6. 1)
7. (1) The value of lattice energy depends on the charges present on the two ions and the distance between them.
8. (2) For compounds containing cations of same charge, lattice energy increases as the size of the cation decreases. Thus, NaF has highest lattice energy. The size of cations is in the order: $\text{Na}^+ < \text{K}^+ < \text{Rb}^+ < \text{Cs}^+$
9. (4) In SiCl_4 difference between electronegativity of Si (1.8) and chlorine (3.0) is higher than in other given compounds.
10. (2) Hydrogen fluoride has a large value of dipole moment. This is due to very high electronegativity of the fluorine as a result it pulls electrons strongly.
11. (2) The stability of the ionic bond depends upon the lattice energy which is expected to be more between Mg and F due to +2 charge on Mg atom.
12. (4) In SF_4 molecules central S-atom is surrounded by 10 valence electrons and it is hypervalent compound.
13. (4) In metallic bonds, each ion is surrounded by equal number of oppositely charged electrons, hence have equal electrostatic attraction from all sides and hence do not have directional characteristics.
14. (1) The set of compounds BCl_3 , SiCl_4 , PCl_3 are predominantly covalent compounds. NH_4Br and NaI ionic compounds and Al contains metallic lattice.
15. (2) According to Fajan's rule smaller, highly charged cation has greatest covalent character while large cation with smaller charge has greatest ionic character.

16. (1) In ionic solids, the sum of the electron gain enthalpy and the ionization enthalpy may be positive but still the crystal structure gets stabilized due to the energy released in the formation of the crystal lattice.
17. (2) According to Fajan's rule, higher charge on the ions, more covalent is the compound.
18. (1)
19. 4)

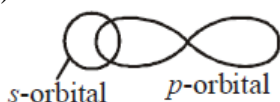


20. 2) In CN^- ion, formal negative charge is on nitrogen atom due to lone pair of electrons.
21. 2)
 $\text{NO}^-(16) - \text{B.O.} = 2$ $\text{O}_2(16) - \text{B.O.} = 2$
 $\text{NO}^+(14) - \text{B.O.} = 3$ $\text{NO}(15) - \text{B.O.} = 2.5$
 Higher the bond order lower is the bond length.
 Hence NO^+ will have smallest bond.
22. 3) In CO_3^{2-} , due to resonance, $\text{C}=\text{O}$ bond length is in between triple and double bond, i.e. in between 1.2 and 1.34. Thus, answer is 1.29 Å.
23. (2) Both NO_2 and O_3 have angular shape and hence will have net dipole moment.
24. (3) I and II structure shown above constitute the canonical structure. III structure represents the structure of O_3 more accurately. This is also called resonance hybrid.
25. (1) According to Fajan's rule, as the charge on the cation increases, and size decreases, its tendency to polarise the anion increases. This brings more and more covalent nature to electrovalent compounds. Hence AlCl_3 shows maximum covalent character.
26. (4)
27. (3) The dipole moment of symmetrical molecules is zero.



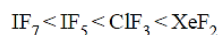
Triangular planar (symmetrical molecule)

28. (1) The dipole moment of two dipoles inclined at an angle θ is given by the equation $\mu = \sqrt{X^2 + Y^2 + 2XY \cos \theta}$, $\cos 90^\circ = 0$. Since the angle increases from 90° to 180° , the value of $\cos \theta$ becomes more and more -ve and hence resultant dipole moment decreases. Thus, dipole moment is maximum when $\theta = 90^\circ$.
29. (4) In case of anions having same charge, as the size of anion increases, polarisability of anion also increases.
30. (3) If the structure of water is linear, then $\mu = 0$, hence it will be non-polar and thus the solubility of polar compound in water cannot be explained.
31. 1)



The overlap between s - and p -orbitals occurs along internuclear axis and hence the angle is 180° .

32. 2) Equilateral or triangular planar shape involves sp^2 hybridization.
33. (3) The bond length decreases in the order $sp^3 > sp^2 > sp$. Because of the triple bond, the carbon-carbon bond is shortest.
34. (1) The number of lone pairs of electrons on central atom in various given species are
- | Species | Number of lone pairs on central atom |
|----------------|--------------------------------------|
| IF_7 | nil |
| IF_5 | 1 |
| ClF_3 | 2 |
| XeF_2 | 3 |



Thus the correct increasing order is 0 1 2 3

35. 2) BF_3 involves sp^2 -hybridization.

36. (3) In XeF_2 and IF_2 both XeF_2 and IF_2 – are sp^3d hybridized

and have trigonal bipyramidal (linear) shape due to presence of 3 *lp* of electrons.

37. (1) The bond angle decreases on moving down the group due to decrease in bond pair-bond pair repulsion.

NH_3	PH_3	AsH_3	SbH_3	BiH_3
107°	94°	92°	91°	90°

This can also be explained by the fact that as the size of central atom increases and its electronegativity decreases. Thus distance between bond pairs of electron increases and *bp-bp* repulsion decreases. As a result bond angle decreases from NH_3 to BiH_3 .

38. (2) Hybridisation is sp^3 and shape pyramidal.

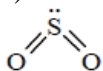
39. (1) BF_3 is sp^2 hybridised. So, it is trigonal planar. NH_3 , and PCl_3 have sp^3 hybridisation, hence have trigonal pyramidal shape. IF_3 , has sp^3d hybridisation and has T-shape.

40. (1) Linear combination of two hybridized orbitals leads to the formation of sigma bond.

41. (3) As sigma bond is stronger than the π (pi) bond, so it must be having higher bond energy than π (pi) bond.

42. (3) $15\sigma + 3\pi$

43. (4)



$lp = 1$

$bp = 4$

44. (1) Number of σ -bonds = 14

45. (4) 46. (2)

47. (4) BrF_5 has square pyramidal geometry.

48. (2) Molecule or ion having sp hybridisation and no lone pair of electrons is linear. CO_2 $H = 1/2 (4 + 0 + 0 - 0) = 2$ sp (linear shape)

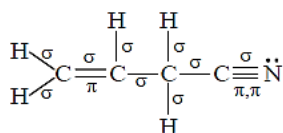
49. (1)

50. (2) SeF_4 has distorted tetrahedral geometry while CH_4 has tetrahedral geometry.

51. 2)

Molecule	Hybridization
SO_3	sp^2
C_2H_2	sp
C_2H_4	sp^2
CH_4	sp^3
CO_2	sp

52. 2) Allyl cyanide is :

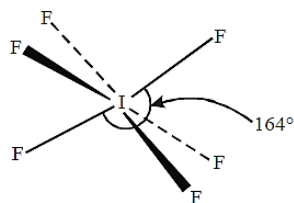


It contains 9 sigma bonds, 3 pi bonds and 1 lone pair of electrons.

53. (4) The bond angle will be exactly $109^\circ.28'$ when the central atom is sp^3 hybridised and all bonds have same atom. CCl_4 has all identical bonds (C – Cl) and central carbon is sp^3 hybridised. So, it has bond angle exactly $109^\circ.28'$.

54. (3) H₂O, NH₃ and CH₄ all are *sp*³ hybridized but due to two *lp* – *lp* repulsions, bond angle in H₂O (104.5°) is lower than in NH₃ (107°) which has one *lp* and CH₄ (109° 28') which has no *lp*. BeF₂ on the other hand, has *sp* hybridization and hence has a bond angle of 180°.

55. (1) The structure of IF₆ – is distorted octahedral This is due to presence of a “weak” lone pair.

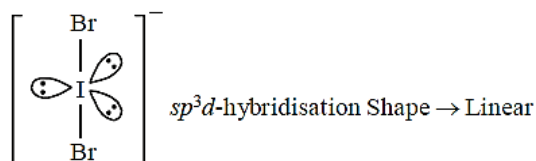


56. (2)

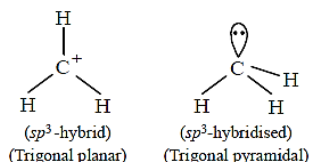
57. (3) Applying VSEPR theory, both NF₃ and H₂O are *sp*³ hybridized.

58. (3) 59. (1) 60. (3) 61. (2)

62. 1)



63. 1)



64. 3) By *sp*²-hybridisation. Hybridisation orbital = 3[3σ – bonds] Unhybridised orbital = 1[1π – bond]

65. 3) Hybridisation :

$$1. \quad \text{SF}_2 \Rightarrow \frac{1}{2}(6+2) = 4 = sp^3$$

$$2. \quad \text{SF}_4 \Rightarrow \frac{1}{2}(6+4) = 5 = sp^3d$$

$$3. \quad \text{SF}_6 \Rightarrow \frac{1}{2}(6+6) = 6 = sp^3d^2$$

66. 4) The strength of a bond depends upon the extent of overlapping. *s*–*s* and *s*–*p* overlapping results in the formation of σ bond but extent of overlapping along internuclear axis is more in case of *s*–*s* overlapping than in *s*–*p*. *p*–*p* overlapping may result in σ bond if overlapping takes place along internuclear axis or may result in π–bond if sideways overlapping takes place. In any case the extent of overlapping is lesser in *p* – *p* than that of the other two, *s*–*s* and *s*–*p*. Hence the correct order is *s* – *s* > *s* – *p* > *p* – *p*

67. 3) N₂⁺ = 7 + 7 – 1 = 13 electrons Configuration is σ1s², σ*1s², σ2s², σ*2s², π2p_x² = π2p_y², σ2p_z¹

$$\text{Bond order} = \frac{nb - na}{2} = \frac{1}{2}(9 - 4) = \frac{1}{2} \times 5 = 2.5$$

68. 3) 69. 4)

M.O. configuration of NO⁺ is :

$$(\sigma 1s)^2 (\sigma^* 1s)^2 (\sigma 2s)^2 (\sigma^* 2s)^2 (\sigma 2p_z)^2 (\pi 2p_x)^2 (\pi 2p_y)^2$$

and M.O. configuration of NO is :

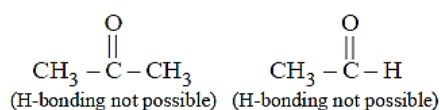
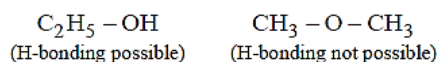
$$(\sigma 1s)^2 (\sigma^* 1s)^2 (\sigma 2s)^2 (\sigma^* 2s)^2 (\sigma 2p_z)^2 (\pi 2p_x)^2 (\pi 2p_y)^2 (\pi^* 2p_x)^1$$

70. 3) H₂⁺ : (σ1s¹); B.O = $\frac{1}{2}(1 - 0) = \frac{1}{2}$

$$H_2^- : (\sigma 1s^2)(\sigma^* 1s^1); B.O = \frac{1}{2}(2-1) = \frac{1}{2}$$

Even though the bond order of H_2^+ and H_2^- are equal but H_2^+ is more stable than H_2^- as in the latter, an electron is present in the antibonding ($\sigma^* 1s$) orbital of higher energy.

71. 1) 72. 2)
 73. 2) One bonding M.O. and one anti-bonding M.O.
 74. 3) NH_3 undergoes H-bonding and hence has the highest b.p. Among the remaining hydrides i.e. PH_3 , AsH_3 and SbH_3 as we move from PH_3 to BiH_3 , the molecular mass increases. As a result the van der Waal's forces of attraction increases and the boiling point increases regularly from PH_3 to BiH_3 .
 75. 3)
 76. 3) In ether, there is no H-bonding while alcohols have intermolecular H-bonding.
 77. 4) Molecules having unpaired electrons show paramagnetism.
 78. 1) Hydrogen bonding is possible only in compounds having hydrogen attached with F, O or N.



79. (4) Due to intermolecular hydrogen bonding in methanol, it exists as associated molecule.
 80. (1) Molecular orbital electronic configuration of these species are :

$$O_2^-(17e^-) = \sigma 1s^2 \sigma^* 1s^2 \sigma 2s^2 \sigma^* 2s^2 \sigma 2p_z^2$$

$$\pi 2p_x^2 = \pi 2p_y^2 \pi^* 2p_x^2 = \pi^* 2p_y^1$$

$$O_2(16e^-) = \sigma 1s^2 \sigma^* 1s^2 \sigma 2s^2 \sigma^* 2s^2 \sigma 2p_z^2$$

$$\pi 2p_x^2 = \pi 2p_y^2 \pi^* 2p_x^1 = \pi^* 2p_y^1$$

$$O_2^{2-}(18e^-) = \sigma 1s^2 \sigma^* 1s^2 \sigma 2s^2 \sigma^* 2s^2 \sigma 2p_z^2$$

$$\pi 2p_x^2 = \pi 2p_y^2 \pi^* 2p_x^2 = \pi^* 2p_y^2$$

Hence number of antibonding electrons are 7, 6 and 8 respectively.

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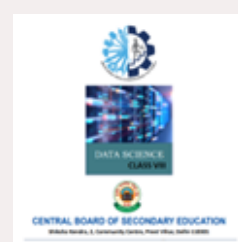
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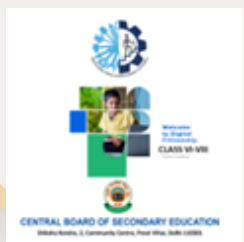
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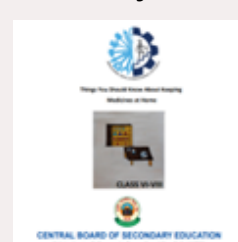
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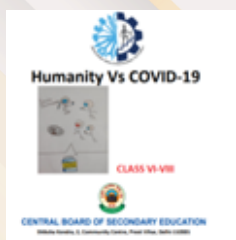
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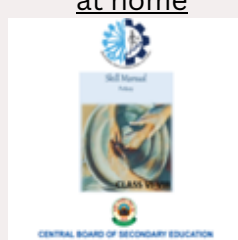
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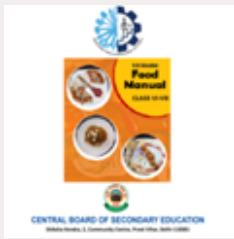
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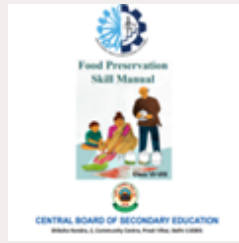
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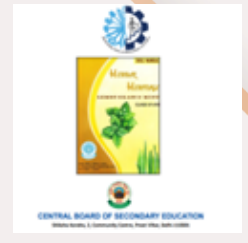
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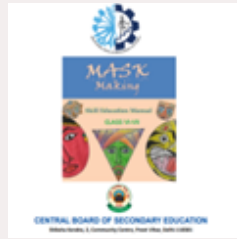
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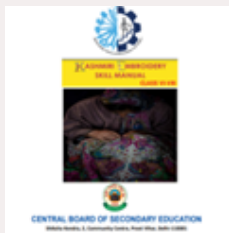
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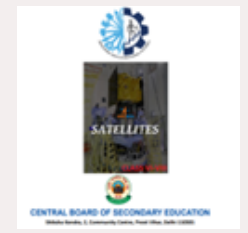
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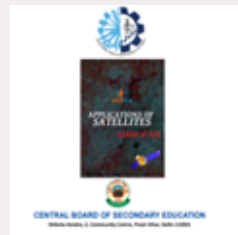
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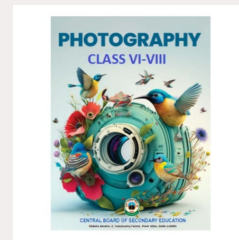
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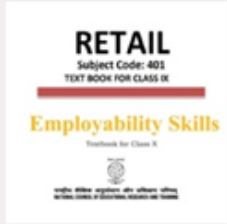


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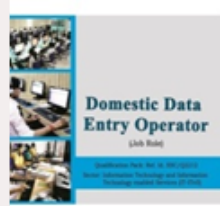


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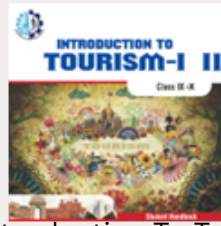
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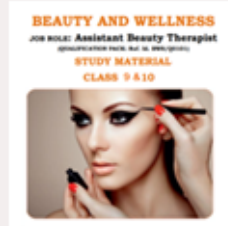
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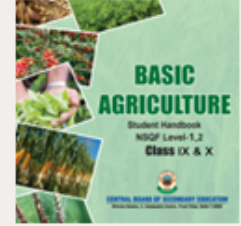
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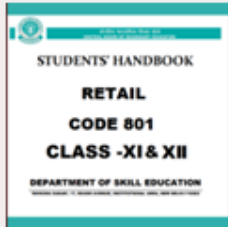


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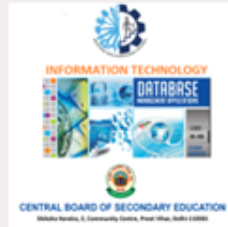


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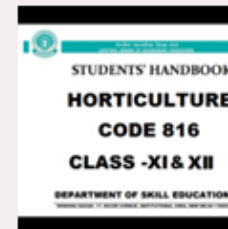
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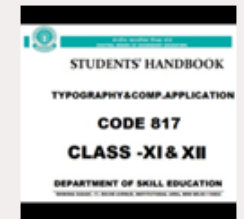
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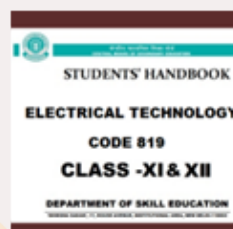
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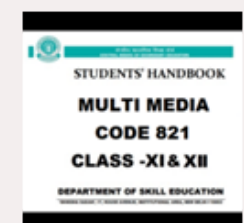
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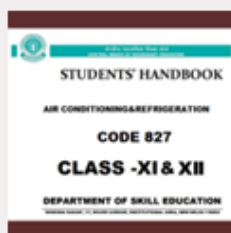
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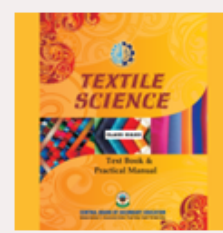
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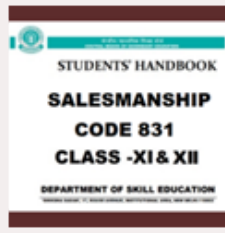
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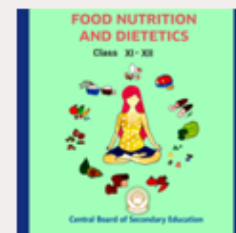
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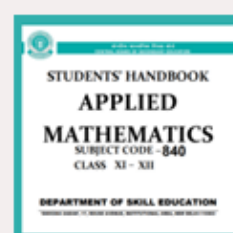
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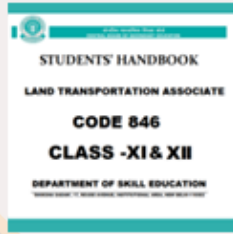
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